Energy Research and Development Division
FINAL PROJECT REPORT

PLUMAS ENERGY EFFICIENCY AND RENEWABLES MANAGEMENT ACTION PLAN (PEER MAP)

Appendix B: Feasibility Study of Biomass Heat for Portola Jr/Sr High School

Prepared for: California Energy Commission
Prepared by: Sierra Institute for Community and Environment

NOVEMBER 2016
CEC-500-2016-067-APB

Feasibility of Biomass Heat for Portola Junior/Senior High School

Portola, California

September 2013

Prepared for:
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Portola Junior/Senior High School: Existing Heating System

The Portola Junior/Senior High School consists of a one-story campus with multiple buildings located at 155 Sixth Avenue, Portola, California, serving approximately 250 students in grades 7-12. The majority of heat for the campus is generated centrally in oil-fired boilers and distributed throughout the school via a hydronic (water-based) heat distribution system.

Boilers

Two boilers provide a large portion of the heat for the Portola campus, and all of the heating oil consumed by the school is consumed in the boilers. The two boilers are located in the mechanical room in the southwest corner of the Workshop building. The primary boiler is a Hurst #2 fuel oil (diesel) fired hot water boiler, circa 2005, with 240 sq. ft. of heating surface area. The Hurst boiler utilizes a Power Flame CR2-OB burner rated at 5.5-17.9 gallons per hour (~2,500 MBH input at high fire). The Power Flame burner is oversized for the Hurst boiler surface area and therefore likely never runs at high fire. The older (circa 1966) Ray boiler continues to serve as backup, but is used sparingly and is soon to be retired (See photos 1-6). The Ray boiler was originally commissioned as a steam boiler rated at 2.5 million BTUs per hour input, with 500 square feet of heating surface area. This boiler was later converted to, and currently operates as, a hot water boiler.

Main School Building

Heat is delivered to the main school building from the boiler room via buried 4" PEX hot water supply and return piping, where it is converted into warm air in air handlers located in an attic mechanical room and distributed with ducting throughout the interior portions the main school building. In addition, there are multiple air handlers providing zone heat in classrooms. Most of the air handling equipment is circa 1974.

Band Building

A separate band building with one large open space and several smaller rooms on its perimeter is heated by five hydronic unit heaters, two in the large space and three additional smaller units in the peripheral rooms. Three additional modular campus buildings are heated with electricity, but were outfitted with stub-ups for hydronic heat from the boiler room, when the entire campus piping was upgraded last year to PEX. These modular building could be converted to hot water heat, lowering energy costs.

Workshop Building

The workshop building is heated separately because it has a high heat demand due to its dust vacuum system that results in a high rate of air exchange. The shop has its

own Hastings #2 fuel oil (diesel) fired furnace using a Gordon Piatt burner rated at 850,000 BTUs per hour output.

Fuel Storage

The school stores its fuel oil in two 10,000 gallon tanks located at the rear of the school. Its fuel use in 2011-2012 was 22,640 gallons of fuel at a cost of ~$79,500. Recent fueling have cost the district $3.75 per gallon, which was used as the oil price in the proforma financials.

Technology Assessed

Due to Portola's location in Plumas County, with nearby access to the Plumas National Forest, this study focused on wood chip fired boiler systems. The assessment assumed state-of-the-art boiler systems that incorporates full automation of all major functions, including automatic ignition, unattended operation, and automatic de-ashing. Further, we assume that a supplier of screened and seasoned wood chips with a specification of 2" minus and 35% MC will be available. Boilers that green wood chips are available, but would add cost. The system modeled has the components required for consistently low emissions levels with variable quality fuels: an oxygen sensor and flue gas temperature sensor-based combustion control system; distinct primary and secondary combustion zones; and flue gas recirculation.

For fuel storage, the suggested method is to utilize two self-contained chip (roll-off) bins that allow refueling of one bin, while the other is full of fuel. The boiler pad would include space for both bins which would be placed onto a rack system that allows wood chips to be auto-fed into the boiler. This system would require virtually no site cleanup, and the bins would be equipped with integrated reclaim technology (scraper floor system) that would prevent the chips from bridging on cold days. The delivery driver can simply load the filled bin onto a rack and hook up an electrical plug to power the moving floor, then drive away with the empty bin for refilling.

Emissions and Air Quality

Due to air quality concerns in the area, Wisewood also considered additional particulate controls, including an electrostatic precipitator (ESP). When operated with clean dry fuel, most modern biomass boiler systems can achieve particulate emission levels at or below 100 mg/m3, which is considered a low level of emissions. If this level must be guaranteed in all circumstances, or lower levels must be met, then the inclusion of an ESP in the system could further reduce the already low particulate emissions to a level of approximately 20 mg/M^3, which is considered to be a very low emission rate. The added cost of the ESP (approximately $310,000) would go to cover the cost of the ESP equipment itself, the additional electrical power and control requirements, and the additional costs associated with the larger concrete pad needed to support the ESP housing, which has a footprint equal to the biomass boiler itself. The inclusion of the ESP should only be considered after

consulting the local and state air quality authorities, and after the final choice of boiler technology has been decided upon (which is in large part a function of fuel source). If a consistent source of clean dry wood chips can be guaranteed, emissions levels approaching 20 mg/M^3 may be achievable without the ESP. Thus an ESP should only be considered on an "as needed" basis.

Mechanical Integration Issues

Portola Junior/Senior High School has an ideal layout for biomass heating. Its multi-building campus already uses hydronic heat distribution and its primary heating medium, and its remaining electric-heated buildings have been prepared to receive hydronic heat at each building. Because the proposed system would utilize the existing heat distribution network, it would also use the existing thermostats and central temperature controls, requiring virtually no training or behavioral change by school staff.

Site Concerns

Wisewood has identified a location at the south end of the school property, behind the band building and wood shop (identified in red on the attached site map), that would be an excellent location for the boiler. This location slopes upward from the school buildings and has direct road access that would allow delivery trucks to pull up to the boiler, deliver wood chip bins, and continue out around the back of the school without have to turnaround, speeding delivery and onsite time. This site would require only minimal trenching and piping, estimated at 100 feet, to reach the existing boiler room and central hydronic distribution system. As trenching and insulated PEX pipes generally make up a large portion of the construction budget, this is an ideal location to minimize those costs.

One large consideration is the school's impending decision on whether to move forward with a new propane-fired boiler system. The school district is contemplating a conversion to propane heat, including a new boiler installation; the school would send its newer Hurst oil-fired boiler to an elementary school in the district.

Financial analysis

In both cases below, Wisewood assumed a fossil fuel boiler replacement and propane conversion cost of $450,000, scheduled for 2014 (information provided by school maintenance staff). This was included as an avoided cost in the economic calculations, as the school will have to spend that money to continue to use its fossil fuel boiler system. The full economic analysis worksheet is included in the appendix to this report.

The total estimated cost for a new biomass thermal energy system fed by wood chips and including an ESP at Portola High School is $1,280,000. This number includes, but is not limited to: project development and management; design and engineering; permitting; equipment; labor; interconnection with existing systems; site work;

concrete; building installation; 10% unlisted items allowance; and 11% contingency allowance.

Assuming an escalation rate of 5.8% on heating oil, 2.0% on woody biomass, and 3.0% on electricity, the estimated net present value over 25 years is $1.237 million, equivalent to internal rate of return (IRR) of 11.3% on the initial capital investment. Taking into account remaining heating fuel costs and operations and maintenance costs, the proposed system would become cash-positive after year 10.

Alternatively, the same biomass boiler system without an ESP is estimated to cost $970,000. This number includes the same components listed above, with the exception of the ESP. The net present value over 25 years for this system is $1.747 million, equivalent to a IRR of 19.6% on the initial capital investment. This proposed system would become cash-positive in year 8.

Recommendations

To meet the heat demand from Portola High School's main buildings (excluding the wood shop), a biomass boiler rated at 1,365 MBH (400 kW) would cover 92% of current fossil fuel demand. This means that the existing fossil fuel boiler would meet 8% of heat demand, on average; most of this demand is represented on extremely cold ("peak") days and on "shoulder" seasons, when outside temperatures are still cool, but heat is only required for a few hours in the morning or evening. During these times, a fossil fuel boiler can be a more efficient heat source, as they can fire up and down within minutes, whereas the biomass boiler system requires over 30 minutes to warm up and cool down. By sizing the biomass boiler to meet 73% of the peak heat demand, it can cover 92% of total energy needs, putting the biomass boiler to work in the most efficient and economical manner.

Portola High School can expect to use approximately 208 tons of wood fuel per year (based on local heating degree day data) at a total estimated cost of $21,000. The continued use of the existing oil boiler during peak loads and shoulder seasons will cost approximately $5,000. This means a savings $50-60,000 per year over currently oil fuel bills of approximately $75,000-85,000 per year.

Portola Junior/Senior High School is an excellent candidate for biomass heat, and could be a model for woody renewables-heated school campuses across California.

Site Photos

Photo 1. Hurst oil-fired boiler (2005)

Photo 2. Nameplate for Hurst boiler

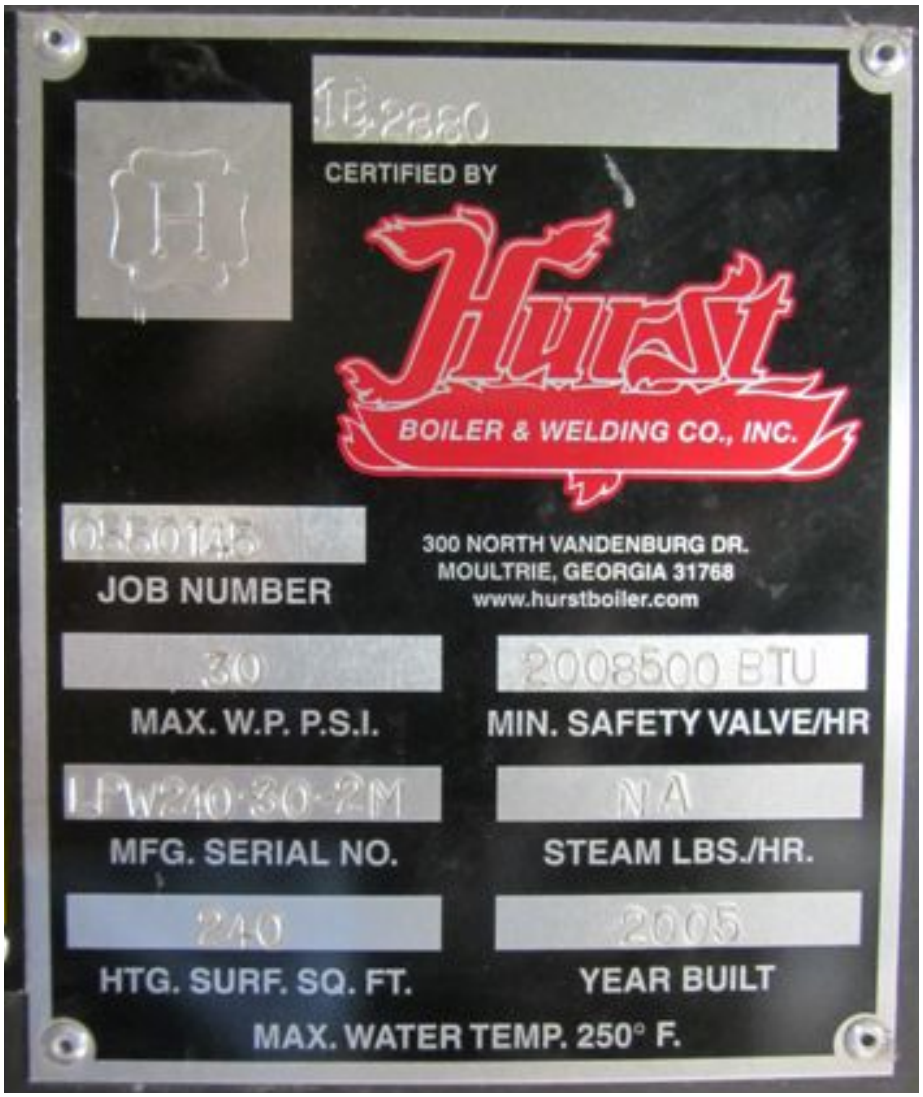


Photo 3. Nameplate for Power Flame burner on Hurst boiler

Photo 4. Ray boiler (1966)

Photo 5. Nameplate for Ray boiler

Photo 6. Nameplate for Ray burner on Ray boiler

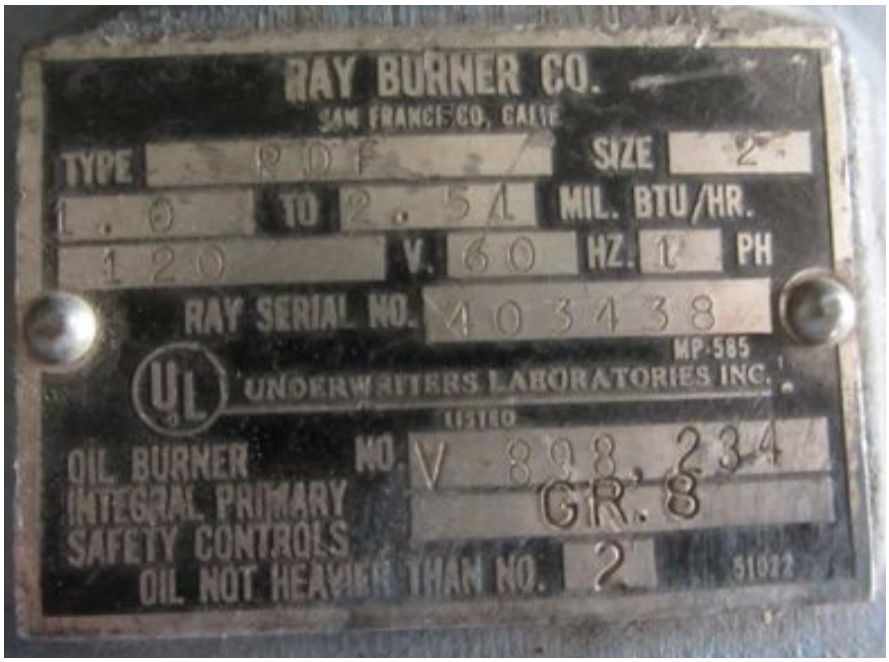


Photo 7. Hastings workshop furnaces

Photo 8. Nameplate for Hastings workshop furnaces

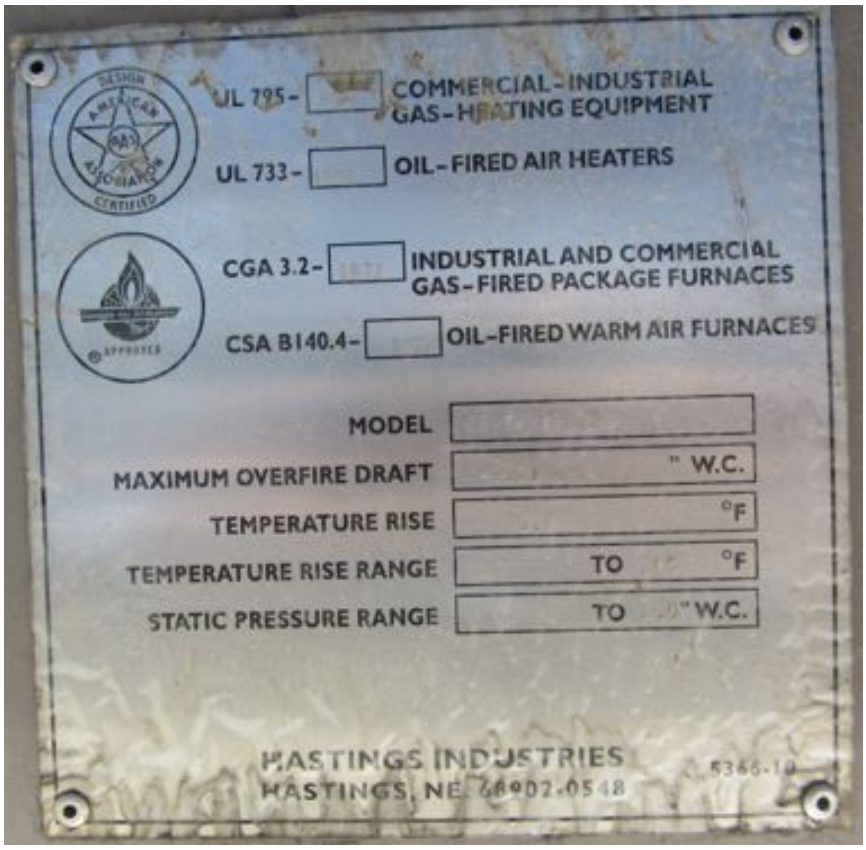


Photo 9. Gordon-Piatt burner on Workshop furnace

Photo 10. Nameplate for Gordon-Piatt burner

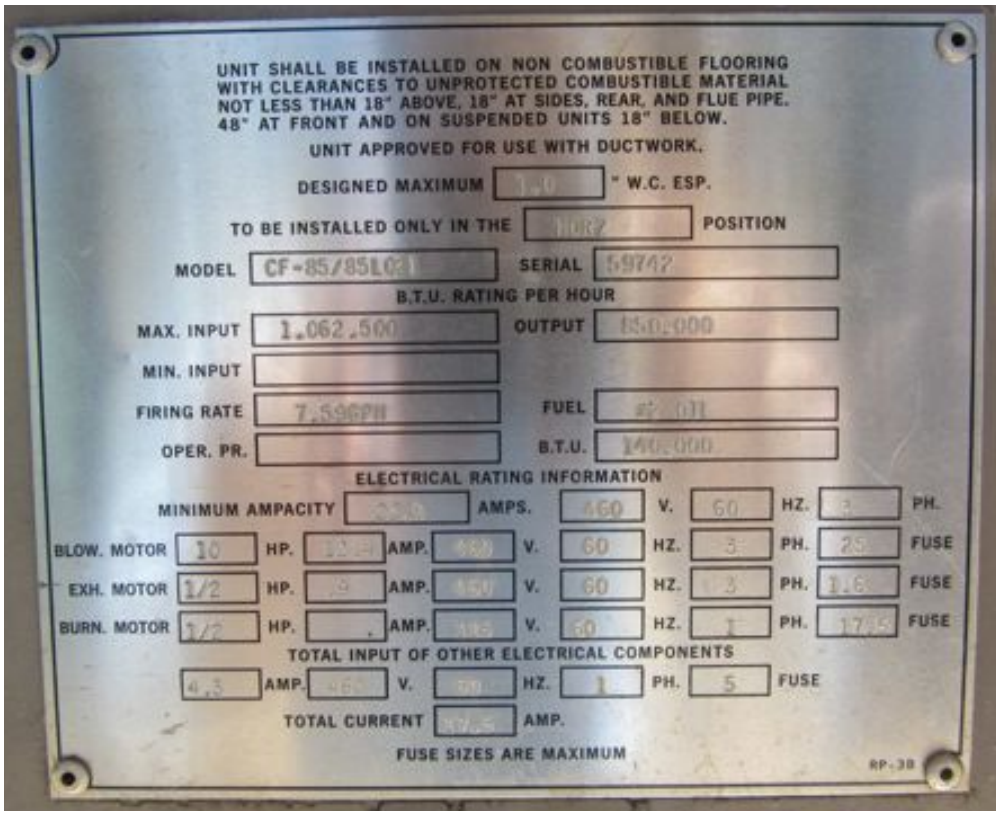


Photo 11. Attic air handler in main school building

Photo 12. Classroom air handler

Photo 13. Proposed location for biomass boiler system (photo taken from perspective of the future boiler slab)

All photos: Wisewood, Inc.

Site map with proposed boiler location


Google earth

Energy Model
and
Proforma Project Financials

Portola High School

Wood-Chip Fired Heating System

Energy Calculations

Contact Andrew Haden
Phone (503) 706-6187
Email andrew@wisewood.us
Address 1001 SE Water Ave, Suite 255
Portland, OR 97214

Project Portola High School
Location Portola, CA
Contact Micheline G. Miglis
Date 9/20/13

System Description Wood-Chip Fired Heating System
System Output (MBH) 1370
Fuel Type Conditioned Forest Biomass (<2" <35%MC)
Workbook Version 3.7.4

Exisiting fossil fuel consumption (MMBtu/HDD)	0.618	Max. electrical demand (kW)	2	Current heating oil use, [gal/yr]	22,640
Existing Furnace Eff.	75%	Average electrical demand (kW)	1.4	Current propane use, [gal/yr]	0
Calculated exisiting heat input (MMBtu/HDD)	0.464	Annual use (kWhr)	3386	Current heating oil cost, [$/yr]	$84,900
Efficiency gains (via EEMs)	0%	Estimated reduction in heating oil use	92%	Current propane cost, [$/yr]	$0
Wood Boiler Eff.	85%	Boiler output, high-fire (MBH)	1365	Projected wood fuel use, [tons/yr]	208
Heating oil cost, $/gal.	$3.75	Boiler output, low-fire (MBH)	341	Projected heating oil use, [gal/yr]	1,757
Propane cost, $/gal.	$2.38	Average boiler output (MBH)	967	Projected wood fuel cost, [$/yr]	$20,809
Electricity cost, $/kWhr	0.17	Wood MC, wet weight basis	25%	Projected heating oil cost, [$/yr]	$4,181
Wood fuel cost, $/green ton	$100.00	Energy of Wood, mmBtu/ton, LHV	12.3	Projected add. elec. cost, [$/yr]	$569
Fossil fuel cost, $/mmBtu	$26.42	Energy of heating oil, Btu/gal, HHV	139000	Operating hours per day	10
Wood fuel cost, $/mmBtu	$8.13	Energy of propane, Btu/gal, HHV	92000	Operating hours, yr	2390

Month	Applicable Heating Degree Days [HDD]	Current gross fossil energy consumption, [MMBtu]	Current net space heat energy input [MMBtu]	Projected net space heat input after EEMs [mmBtu/mo]	Projected gross wood energy consumption, [MMBtu]	Projected gross fossil energy consumption, [MMBtu]
September	42	26	20	20	21	15
October	310	192	144	144	156	34
November	699	432	324	324	351	34
December	695	429	322	322	349	32
January	652	403	302	302	328	34
February	703	435	326	326	353	41
March	841	520	390	390	423	29
April	594	367	275	275	298	15
May	316	195	146	146	159	9
June	194	120	90	90	97	2
July	41	25	19	19	21	0
August	6	4	3	3	3	0
Yearly Total, or Avg,	5091	3,147	2,360	2,360	2,559	244

Net fossil energy savings, [MMBtu/yr] **2,903**

Portola High School

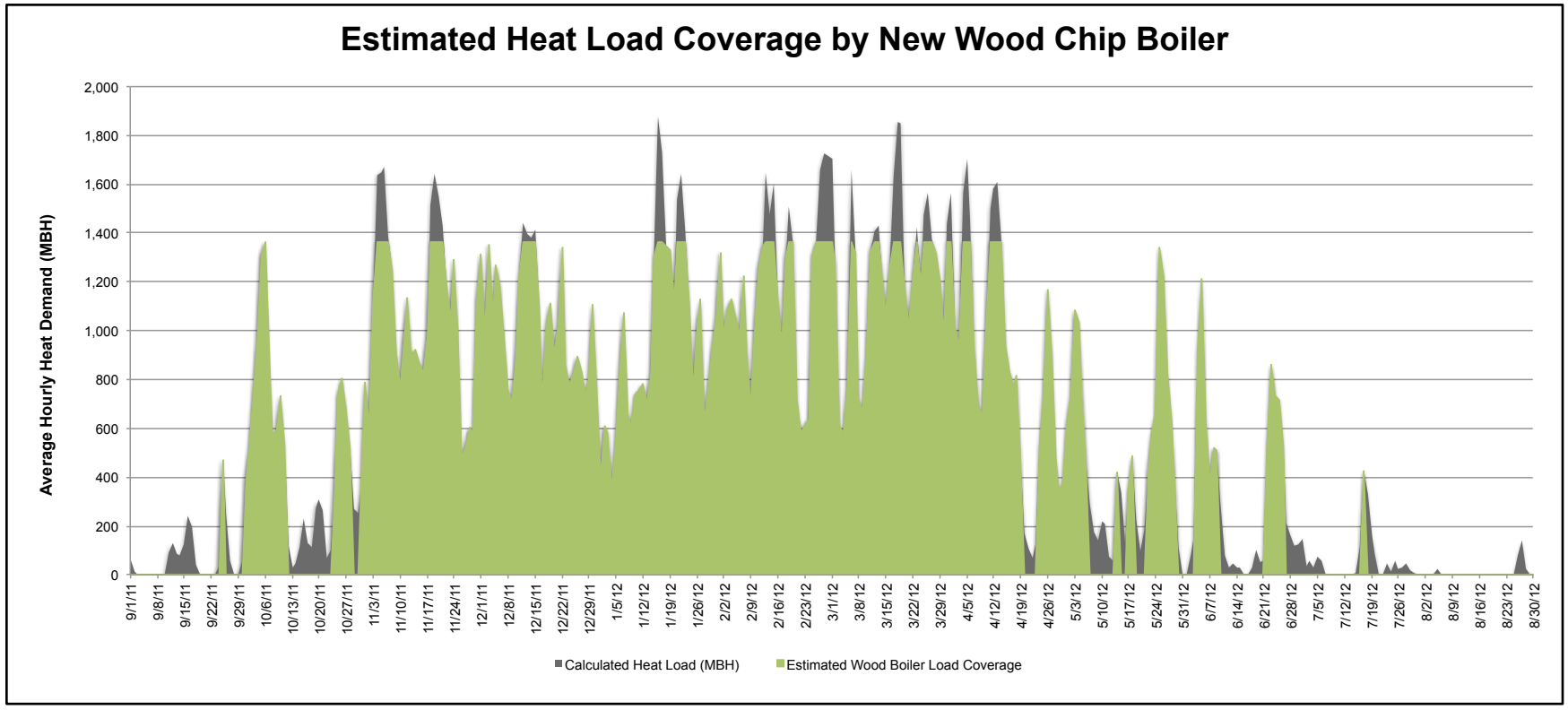
Portola High School

Energy Calculations

Project Portola High School
Location Portola, CA
Contact Micheline G. Miglis
Date 9/20/13

System Description Wood-Chip Fired Heating System
System Output (MBH) 1370
Fuel Type Conditioned Forest Biomass (<2" ·
Workbook Version 3.7.4

Contact Andrew Haden
Phone (503) 706-6187
Email andrew@wisewood.us



Portola High School

Portola High School
Energy Calculations

Project Portola High School
Location Portola, CA
Contact Micheline G. Miglis
Date 9/20/13

Boiler Option Wood-Chip Fired Heating System
System Output (MBH) 1370
Fuel Type Conditioned Forest Biomass (<2" ·
Workbook Version 3.7.4

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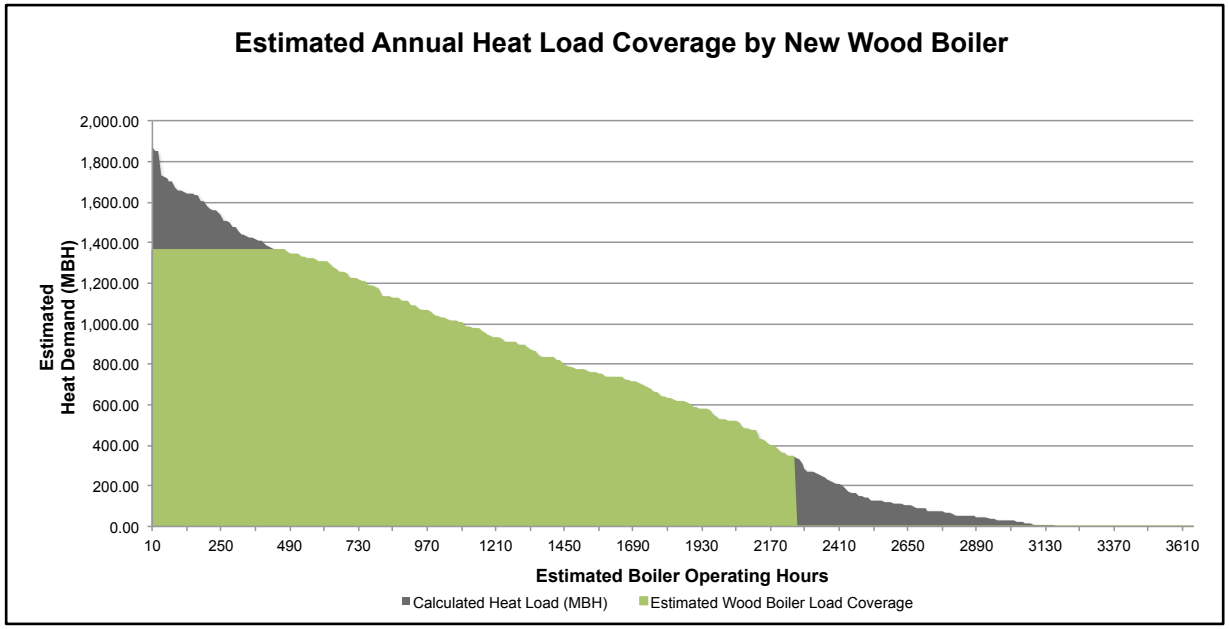

Boiler Output [MBH]	Fossil Fuel Displaced
34	4%
89	11%
136	16%
177	20%
205	23%
266	29%
341	36%
512	51%
750	68%
1024	82%
1365	92%
1842	94%
2457	88%
3241	75%
4265	56%
5459	29%
7165	2%
10236	0%
13648	0%
17060	0%
20472	0%
23884	0%
27296	0%
30708	0%
34120	0%

Portola High School

Wood-Chip Fired Heating System

System Output (MBH) 1370

SUMMARY COST ESTIMATE

Contact Micheline G. Miglis

WORKBOOK VERSION: 3.7.4
ORIG. DATE: 20-Aug-13
REV. DATE: 20-Sep-13

NO.	ITEM DESCRIPTION	UNIT	QTY	UNIT COST	EST HRS	INSTALL. EQUIPMENT	INSTALL. MATERIALS	INSTALL. LABOR	TOTAL
I	**CIVIL/STRUCTURAL:**				160	$10,000	$40,000	$40,000	$90,000
II	**MECHANICAL INSTALLATION:**								
	WOOD FUEL STORAGE AND CONVEYANCE				80	$0	$80,000	$10,000	$90,000
	BIOMASS BOILER				176	$10,000	$280,000	$10,000	$300,000
	PIPING AND PLUMBING				464	$10,000	$30,000	$20,000	$60,000
	SUBTOTAL MECHANICAL INSTALLTION				720	$20,000	$390,000	$40,000	$450,000
III	**PERMITING**					$0	$10,000	$0	$10,000
IV	**MISCELLANEOUS:**					$10,000	$0	$0	$10,000
V	**ELECTRICAL:**				400	$0	$30,000	$30,000	$60,000
	TOTAL DIRECT COST:				1280	$40,000	$470,000	$110,000	$620,000
VI	**INDIRECT COSTS:**								
	GENERAL CONTRACTOR O&P								$110,000
	ENGINEERING, CONSTRUCTION MANAGEMENT & COMMISSIONING								$70,000
VII	**10% UNLISTED ITEMS ALLOWANCE**								$80,000
VIII	**11% CONTINGENCY ALLOWANCE**								$90,000
	TOTAL CAPITAL COST:								$970,000

IX **ITEMS NOT IN THIS ESTIMATE**

- COMPLIANCE TESTING
- ENVIRONMENTAL ENGINEERING
- STORM WATER SYSTEM
- ASH OR RESIDUAL DISPOSAL OFF-SITE
- TAXES NOT INCLUDED

Portola High School

Proforma Project Financial Statement

Contact Andrew Haden
Phone (503) 706-6187
Email andrew@wisewood.us

Project Portola High School
Location Portola, CA
Contact Micheline McGlis
Date 9/20/13

System Description Wood-Chip Fired Heating System
System Output (MBH) 1370
Fuel Type Conditioned Forest Biomass (<2" <35%MC)
Workbook Version 3.7.4

DEBT SERVICE		
Total Installation Cost		$ 970,000
Grants	0%	$ -
Debt Leverage		0.0%
Project Equity		100.0%
Loan Amount		$ -
Amount of Equity		$ 970,000
Annual Rate		5.0%
Term (Years)		20.00

FUEL COSTS	Fossil Fuel	Wood	Electricity
Unit	(mmBtu)	(mmBtu)	(kWhr)
Cost per unit	$26.42	$8.13	$0.17
Escalation Rate	5.8%	2.0%	3.0%

O&M, WOOD	Labor		Electricity
Labor (hrs/wk)	2	Max. electrical draw (kW)	2
$/hr	$30	Average draw (kW)	1.4
Wk/yr	40	Annual use (kWhr)	3386.0
Total/yr	$2,400	Annual cost, pellet boiler	$569
Ann. increase	2%	Oil boiler, blower, kW	5.0
		Oil boiler, elec. kWh	$1

30 YR ACCUMULATED CASH FLOW	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 15	Year 20	Year 25	Year 30
EXISTING HEATING SYSTEM OPERATING COSTS														
Existing Heating System Replacment Cost	$ 450,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Projected Heating Oil Cost	$ 83,155	$ 87,978	$ 93,081	$ 98,480	$ 104,192	$ 110,235	$ 116,628	$ 123,393	$ 130,549	$ 138,121	$ 183,100	$ 242,727	$ 321,770	$ 426,554
O&M Cost	$ 1,263	$ 1,288	$ 1,314	$ 1,340	$ 1,367	$ 1,394	$ 1,422	$ 1,451	$ 1,480	$ 1,509	$ 1,667	$ 1,840	$ 2,031	$ 2,243
Projected Cooling Cost	$ 5,100	$ 5,253	$ 5,411	$ 5,573	$ 5,740	$ 5,912	$ 6,090	$ 6,272	$ 6,461	$ 6,654	$ 7,714	$ 8,943	$ 10,367	$ 12,018
TOTAL	**$ 539,518**	**$ 94,520**	**$ 99,806**	**$ 105,393**	**$ 111,299**	**$ 117,541**	**$ 124,140**	**$ 131,116**	**$ 138,490**	**$ 146,285**	**$ 172,448**	**$ 253,509**	**$ 334,169**	**$ 440,815**
PROPOSED HEATING SYSTEM OPERATING COSTS														
Heating Oil Fuel Cost (Peak and Low Load)	$ 6,452	$ 6,827	$ 7,223	$ 7,642	$ 8,085	$ 8,554	$ 9,050	$ 9,575	$ 10,130	$ 10,718	$ 14,208	$ 18,834	$ 24,968	$ 33,098
Wood Fuel Cost	$ 20,809	$ 21,225	$ 21,649	$ 22,082	$ 22,524	$ 22,974	$ 23,434	$ 23,903	$ 24,381	$ 24,868	$ 27,457	$ 30,314	$ 33,469	$ 36,953
O&M Cost	$ 2,400	$ 2,448	$ 2,497	$ 2,547	$ 2,598	$ 2,650	$ 2,703	$ 2,757	$ 2,812	$ 2,868	$ 3,167	$ 3,496	$ 3,860	$ 4,262
Electrical Cost	$ 569	$ 586	$ 603	$ 622	$ 640	$ 659	$ 679	$ 700	$ 721	$ 742	$ 860	$ 997	$ 1,156	$ 1,341
TOTAL	**$ 30,230**	**$ 31,085**	**$ 31,972**	**$ 32,892**	**$ 33,847**	**$ 34,837**	**$ 35,866**	**$ 36,934**	**$ 38,043**	**$ 39,196**	**$ 45,691**	**$ 53,643**	**$ 63,454**	**$ 75,654**
PROJECT RELATED DEBT														
Beginning Principal Balance	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	#NUM!	#NUM!
Principal Repayments	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	#NUM!	#NUM!
Interest Payments	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	#NUM!	#NUM!
Ending Principal Balance	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	#NUM!	#NUM!
TOTAL DEBT PAYMENT	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
ANNUAL OPERATING COST SAVINGS (LOSS)	**$ 509,288**	**$ 63,434**	**$ 67,833**	**$ 72,501**	**$ 77,452**	**$ 82,704**	**$ 88,274**	**$ 94,182**	**$ 100,447**	**$ 107,089**	**$ 146,790**	**$ 199,867**	**$ 270,715**	**$ 365,161**
Cash Investment (equity)	$ (970,000)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -				
Income (cost savings)	$ 509,288	$ 63,434	$ 67,833	$ 72,501	$ 77,452	$ 82,704	$ 88,274	$ 94,182	$ 100,447	$ 107,089	$ 146,790	$ 199,867	$ 270,715	$ 365,161
Net Cash Flow	**$ (460,712)**	**$ 63,434**	**$ 67,833**	**$ 72,501**	**$ 77,452**	**$ 82,704**	**$ 88,274**	**$ 94,182**	**$ 100,447**	**$ 107,089**	**$ 146,790**	**$ 199,867**	**$ 270,715**	**$ 365,161**
ACCUMULATED CASH FLOW	$ (460,712)	$ (397,278)	$ (329,444)	$ (256,944)	$ (179,492)	$ (96,788)	$ (8,514)	$ 85,669	$ 186,115	$ 293,204	$ 943,131	$ 1,830,172	$ 3,033,898	$ 4,659,987

IRR on Equity	10 YR IRR	15 YR IRR	20 YR IRR	25 YR IRR	30 YR IRR
	10.1%	16.4%	18.6%	19.6%	20.0%

Net Present Value (NPV)		10 YR NPV	15 YR NPV	20 YR NPV	25 YR NPV	30 YR NPV
NPV Discount Rate	3.0%	$ 177,858	$ 619,171	$ 1,138,775	$ 1,747,045	$ 2,455,885

Portola High School

Proforma Project Financial Statement (1% Loan Fund)

Contact Andrew Haden
Phone (503) 706-6187
Email andrew@wisewood.us

Project Portola High School
Location Portola, CA
Contact Micheline G. Miglis
Date 9/20/13

System Description Wood-Chip Fired Heating System
System Output (MBH) 1370
Fuel Type Conditioned Forest Biomass (<2" <35%MC)
Workbook Version 3.7.4

DEBT SERVICE		
Total Installation Cost		$ 970,000
Grants	0%	$ -
Debt Leverage		100.0%
Project Equity		0.0%
Loan Amount		$ 970,000
Amount of Equity		$ -
Annual Rate		1.0%
Term (Years)		20.00

FUEL COSTS	Fossil Fuel	Wood	Electricity
Unit	(mmBtu)	(mmBtu)	(kWhr)
Cost per unit	$26.42	$8.13	$0.17
Escalation Rate	5.8%	2.0%	3.0%

O&M, WOOD	Labor		Electricity
Labor (hrs/wk)	2	Max. electrical draw (kW)	2
$/hr	$30	Average draw (kW)	1.4
Wk/yr	40	Annual use (kWhr)	3386.0
Total/yr	$2,400	Annual cost, pellet boiler	$569
Ann. increase	2%	Oil boiler, blower, kW	5.0
		Oil boiler, elec. kWh	$1

30 YR ACCUMULATED CASH FLOW	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 15	Year 20	Year 25	Year 30
EXISTING HEATING SYSTEM OPERATING COSTS														
Existing Heating System Replacment Cost	$ 450,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Projected Heating Oil Cost	$ 83,155	$ 87,978	$ 93,081	$ 98,480	$ 104,192	$ 110,235	$ 116,628	$ 123,393	$ 130,549	$ 138,121	$ 183,100	$ 242,727	$ 321,770	$ 426,554
O&M Cost	$ 1,263	$ 1,288	$ 1,314	$ 1,340	$ 1,367	$ 1,394	$ 1,422	$ 1,451	$ 1,480	$ 1,509	$ 1,667	$ 1,840	$ 2,031	$ 2,243
Projected Cooling Cost	$ 5,100	$ 5,253	$ 5,411	$ 5,573	$ 5,740	$ 5,912	$ 6,090	$ 6,272	$ 6,461	$ 6,654	$ 7,714	$ 8,943	$ 10,367	$ 12,018
TOTAL	**$ 539,518**	**$ 94,520**	**$ 99,806**	**$ 105,393**	**$ 111,299**	**$ 117,541**	**$ 124,140**	**$ 131,116**	**$ 138,490**	**$ 146,285**	**$ 172,448**	**$ 253,509**	**$ 334,169**	**$ 440,815**
PROPOSED HEATING SYSTEM OPERATING COSTS														
Heating Oil Fuel Cost (Peak and Low Load)	$ 6,452	$ 6,827	$ 7,223	$ 7,642	$ 8,085	$ 8,554	$ 9,050	$ 9,575	$ 10,130	$ 10,718	$ 14,208	$ 18,834	$ 24,968	$ 33,098
Wood Fuel Cost	$ 20,809	$ 21,225	$ 21,649	$ 22,082	$ 22,524	$ 22,974	$ 23,434	$ 23,903	$ 24,381	$ 24,868	$ 27,457	$ 30,314	$ 33,469	$ 36,953
O&M Cost	$ 2,400	$ 2,448	$ 2,497	$ 2,547	$ 2,598	$ 2,650	$ 2,703	$ 2,757	$ 2,812	$ 2,868	$ 3,167	$ 3,496	$ 3,860	$ 4,262
Electrical Cost	$ 569	$ 586	$ 603	$ 622	$ 640	$ 659	$ 679	$ 700	$ 721	$ 742	$ 860	$ 997	$ 1,156	$ 1,341
TOTAL	**$ 30,230**	**$ 31,085**	**$ 31,972**	**$ 32,892**	**$ 33,847**	**$ 34,837**	**$ 35,866**	**$ 36,934**	**$ 38,043**	**$ 39,196**	**$ 45,691**	**$ 53,643**	**$ 63,454**	**$ 75,654**
PROJECT RELATED DEBT														
Beginning Principal Balance	$ 970,000	$ 925,947	$ 881,454	$ 836,515	$ 791,128	$ 745,286	$ 698,986	$ 652,223	$ 604,993	$ 557,290	$ 311,523	$ -	#NUM!	#NUM!
Principal Repayments	$ (44,053)	$ (44,493)	$ (44,938)	$ (45,388)	$ (45,842)	$ (46,300)	$ (46,763)	$ (47,231)	$ (47,703)	$ (48,180)	$ (50,638)	$ -	#NUM!	#NUM!
Interest Payments	$ (9,700)	$ (9,259)	$ (8,815)	$ (8,365)	$ (7,911)	$ (7,453)	$ (6,990)	$ (6,522)	$ (6,050)	$ (5,573)	$ (3,115)	$ -	#NUM!	#NUM!
Ending Principal Balance	$ 925,947	$ 881,454	$ 836,515	$ 791,128	$ 745,286	$ 698,986	$ 652,223	$ 604,993	$ 557,290	$ 509,110	$ 260,886	$ -	#NUM!	#NUM!
TOTAL DEBT PAYMENT	**$ 53,753**	**$ 53,753**	**$ 53,753**	**$ 53,753**	**$ 53,753**	**$ 53,753**	**$ 53,753**	**$ 53,753**	**$ 53,753**	**$ 53,753**	**$ 53,753**	**$ -**	**$ -**	**$ -**
ANNUAL OPERATING COST SAVINGS (LOSS)	**$ 455,535**	**$ 9,681**	**$ 14,080**	**$ 18,748**	**$ 23,699**	**$ 28,951**	**$ 34,522**	**$ 40,429**	**$ 46,694**	**$ 53,336**	**$ 93,037**	**$ 199,867**	**$ 270,715**	**$ 365,161**
Cash Investment (equity)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -				
Income (cost savings)	$ 455,535	$ 9,681	$ 14,080	$ 18,748	$ 23,699	$ 28,951	$ 34,522	$ 40,429	$ 46,694	$ 53,336	$ 93,037	$ 199,867	$ 270,715	$ 365,161
Net Cash Flow	**$ 455,535**	**$ 9,681**	**$ 14,080**	**$ 18,748**	**$ 23,699**	**$ 28,951**	**$ 34,522**	**$ 40,429**	**$ 46,694**	**$ 53,336**	**$ 93,037**	**$ 199,867**	**$ 270,715**	**$ 365,161**
ACCUMULATED CASH FLOW	$ 455,535	$ 465,217	$ 479,297	$ 498,045	$ 521,744	$ 550,695	$ 585,216	$ 625,646	$ 672,339	$ 725,675	$ 1,106,838	$ 1,993,879	$ 3,197,605	$ 4,823,694

IRR on Equity	10 YR IRR	15 YR IRR	20 YR IRR	25 YR IRR	30 YR IRR

Net Present Value (NPV)		10 YR NPV	15 YR NPV	20 YR NPV	25 YR NPV	30 YR NPV
NPV Discount Rate	3.0%	$ 661,083	$ 919,220	$ 1,438,825	$ 2,047,095	$ 2,755,934

Portola High School

Wood-Chip Fired Heating System (w/ ESP)

System Output (MBH) 1370

SUMMARY COST ESTIMATE **Contact** Micheline G. Miglis

WORKBOOK VERSION: 3.7.4
ORIG. DATE: 20-Aug-13
REV. DATE: 20-Sep-13

NO.	ITEM DESCRIPTION	UNIT	QTY	UNIT COST	EST HRS	INSTALL. EQUIPMENT	INSTALL. MATERIALS	INSTALL. LABOR	TOTAL
I	**CIVIL/STRUCTURAL:**				160	$10,000	$60,000	$40,000	$110,000
II	**MECHANICAL INSTALLATION:**								
	WOOD FUEL STORAGE AND CONVEYANCE				80	$0	$80,000	$10,000	$90,000
	BIOMASS BOILER				176	$10,000	$280,000	$10,000	$300,000
	PIPING AND PLUMBING				464	$10,000	$30,000	$20,000	$60,000
	ELECTROSTATIC PRECIPITATOR				464	$0	$130,000	$20,000	$150,000
	SUBTOTAL MECHANICAL INSTALLTION				720	$20,000	$510,000	$70,000	$600,000
III	**PERMITING**					$0	$10,000	$0	$10,000
IV	**MISCELLANEOUS:**					$10,000	$0	$0	$10,000
V	**ELECTRICAL:**				480	$0	$50,000	$40,000	$90,000
	TOTAL DIRECT COST:				1360	$40,000	$630,000	$150,000	$820,000
VI	**INDIRECT COSTS:**								
	GENERAL CONTRACTOR O&P								$140,000
	ENGINEERING, CONSTRUCTION MANAGEMENT & COMMISSIONING								$100,000
VII	**10% UNLISTED ITEMS ALLOWANCE**								$100,000
VIII	**11% CONTINGENCY ALLOWANCE**								$120,000
	TOTAL CAPITAL COST:								$1,280,000

IX ITEMS NOT IN THIS ESTIMATE

- COMPLIANCE TESTING
- ENVIRONMENTAL ENGINEERING
- STORM WATER SYSTEM
- ASH OR RESIDUAL DISPOSAL OFF-SITE
- TAXES NOT INCLUDED

Portola High School

Proforma Project Financial Statement

Contact Andrew Haden
Phone (503) 706-6187
Email andrew@wisewood.us

Project Portola High School
Location Portola, CA
Contact Micheline McGlis
Date 9/20/13

System Description Wood-Chip Fired Heating System (w/ ESP)
System Output (MBH) 1370
Fuel Type Conditioned Forest Biomass (<2" <35%MC)
Workbook Version 3.7.4

DEBT SERVICE		
Total Installation Cost		$ 1,280,000
Grants	0%	$ -
Debt Leverage		0.0%
Project Equity		100.0%
Loan Amount		$ -
Amount of Equity		$ 1,280,000
Annual Rate		5.0%
Term (Years)		20.00

FUEL COSTS	Fossil Fuel	Wood	Electricity
Unit	(mmBtu)	(mmBtu)	(kWhr)
Cost per unit	$26.42	$8.13	$0.17
Escalation Rate	5.8%	2.0%	3.0%

O&M, WOOD	Labor		Electricity
Labor (hrs/wk)	2	Max. electrical draw (kW)	3
$/hr	$75	Average draw (kW)	2.1
Wk/yr	40	Annual use (kWhr)	5078.9
Total/yr	$6,000	Annual cost, pellet boiler	$853
Ann. increase	2%	Oil boiler, blower, kW	5.0
		Oil boiler, elec. kWh	$2

30 YR ACCUMULATED CASH FLOW	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 15	Year 20	Year 25	Year 30
EXISTING HEATING SYSTEM OPERATING COSTS														
Existing Heating System Replacment Cost	$ 450,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Projected Heating Oil Cost	$ 83,155	$ 87,978	$ 93,081	$ 98,480	$ 104,192	$ 110,235	$ 116,628	$ 123,393	$ 130,549	$ 138,121	$ 183,100	$ 242,727	$ 321,770	$ 426,554
O&M Cost	$ 1,263	$ 1,288	$ 1,314	$ 1,340	$ 1,367	$ 1,394	$ 1,422	$ 1,451	$ 1,480	$ 1,509	$ 1,667	$ 1,840	$ 2,031	$ 2,243
TOTAL	**$ 534,418**	**$ 89,267**	**$ 94,395**	**$ 99,820**	**$ 105,559**	**$ 111,629**	**$ 118,051**	**$ 124,843**	**$ 132,029**	**$ 139,631**	**$ 165,177**	**$ 244,567**	**$ 323,802**	**$ 428,797**
PROPOSED HEATING SYSTEM OPERATING COSTS														
Heating Oil Fuel Cost (Peak and Low Load)	$ 6,452	$ 6,827	$ 7,223	$ 7,642	$ 8,085	$ 8,554	$ 9,050	$ 9,575	$ 10,130	$ 10,718	$ 14,208	$ 18,834	$ 24,968	$ 33,098
Wood Fuel Cost	$ 20,809	$ 21,225	$ 21,649	$ 22,082	$ 22,524	$ 22,974	$ 23,434	$ 23,903	$ 24,381	$ 24,868	$ 27,457	$ 30,314	$ 33,469	$ 36,953
O&M Cost	$ 6,000	$ 6,120	$ 6,242	$ 6,367	$ 6,495	$ 6,624	$ 6,757	$ 6,892	$ 7,030	$ 7,171	$ 7,917	$ 8,741	$ 9,651	$ 10,655
Electrical Cost	$ 853	$ 879	$ 905	$ 932	$ 960	$ 989	$ 1,019	$ 1,049	$ 1,081	$ 1,113	$ 1,291	$ 1,496	$ 1,735	$ 2,011
TOTAL	**$ 34,114**	**$ 35,050**	**$ 36,020**	**$ 37,024**	**$ 38,064**	**$ 39,142**	**$ 40,260**	**$ 41,419**	**$ 42,622**	**$ 43,870**	**$ 50,872**	**$ 59,386**	**$ 69,822**	**$ 82,717**
PROJECT RELATED DEBT														
Beginning Principal Balance	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	#NUM!	#NUM!
Principal Repayments	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	#NUM!	#NUM!
Interest Payments	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	#NUM!	#NUM!
Ending Principal Balance	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	#NUM!	#NUM!
TOTAL DEBT PAYMENT	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
ANNUAL OPERATING COST SAVINGS (LOSS)	**$ 500,304**	**$ 54,216**	**$ 58,375**	**$ 62,796**	**$ 67,495**	**$ 72,487**	**$ 77,791**	**$ 83,425**	**$ 89,408**	**$ 95,761**	**$ 133,895**	**$ 185,181**	**$ 253,979**	**$ 346,080**
Cash Investment (equity)	$ (1,280,000)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -				
Income (cost savings)	$ 500,304	$ 54,216	$ 58,375	$ 62,796	$ 67,495	$ 72,487	$ 77,791	$ 83,425	$ 89,408	$ 95,761	$ 133,895	$ 185,181	$ 253,979	$ 346,080
Net Cash Flow	**$ (779,696)**	**$ 54,216**	**$ 58,375**	**$ 62,796**	**$ 67,495**	**$ 72,487**	**$ 77,791**	**$ 83,425**	**$ 89,408**	**$ 95,761**	**$ 133,895**	**$ 185,181**	**$ 253,979**	**$ 346,080**
ACCUMULATED CASH FLOW	$ (779,696)	$ (725,480)	$ (667,105)	$ (604,308)	$ (536,813)	$ (464,326)	$ (386,535)	$ (303,110)	$ (213,702)	$ (117,941)	$ 470,730	$ 1,288,020	$ 2,412,276	$ 3,947,776

IRR on Equity

10 YR IRR	15 YR IRR	20 YR IRR	25 YR IRR	30 YR IRR
-2.9%	6.0%	9.6%	11.3%	12.3%

Net Present Value (NPV)
NPV Discount Rate 3.0%

10 YR NPV	15 YR NPV	20 YR NPV	25 YR NPV	30 YR NPV
$ (208,852)	$ 190,776	$ 669,436	$ 1,237,467	$ 1,906,739

Portola High School

Proforma Project Financial Statement (1% Loan Fund)

Contact Andrew Haden
Phone (503) 706-6187
Email andrew@wisewood.us

Project Portola High School
Location Portola, CA
Contact Micheline G. Miglis
Date 9/20/13

System Description Wood-Chip Fired Heating System (w/ ESP)
System Output (MBH) 1370
Fuel Type Conditioned Forest Biomass (<2" <35%MC)
Workbook Version 3.7.4

DEBT SERVICE		
Total Installation Cost		$ 1,280,000
Grants	0%	$ -
Debt Leverage		100.0%
Project Equity		0.0%
Loan Amount		$ 1,280,000
Amount of Equity		$ -
Annual Rate		1.0%
Term (Years)		20.00

FUEL COSTS	Fossil Fuel	Wood	Electricity
Unit	(mmBtu)	(mmBtu)	(kWhr)
Cost per unit	$26.42	$8.13	$0.17
Escalation Rate	5.8%	2.0%	3.0%

O&M, WOOD	Labor		Electricity
Labor (hrs/wk)	2	Max. electrical draw (kW)	3
$/hr	$75	Average draw (kW)	2.1
Wk/yr	40	Annual use (kWhr)	5078.9
Total/yr	$6,000	Annual cost, pellet boiler	$853
Ann. increase	2%	Oil boiler, blower, kW	5.0
		Oil boiler, elec. kWh	$2

30 YR ACCUMULATED CASH FLOW	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 15	Year 20	Year 25	Year 30
EXISTING HEATING SYSTEM OPERATING COSTS														
Existing Heating System Replacment Cost	$ 450,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Projected Heating Oil Cost	$ 83,155	$ 87,978	$ 93,081	$ 98,480	$ 104,192	$ 110,235	$ 116,628	$ 123,393	$ 130,549	$ 138,121	$ 183,100	$ 242,727	$ 321,770	$ 426,554
O&M Cost	$ 1,263	$ 1,288	$ 1,314	$ 1,340	$ 1,367	$ 1,394	$ 1,422	$ 1,451	$ 1,480	$ 1,509	$ 1,667	$ 1,840	$ 2,031	$ 2,243
TOTAL	**$ 534,418**	**$ 89,267**	**$ 94,395**	**$ 99,820**	**$ 105,559**	**$ 111,629**	**$ 118,051**	**$ 124,843**	**$ 132,029**	**$ 139,631**	**$ 165,177**	**$ 244,567**	**$ 323,802**	**$ 428,797**
PROPOSED HEATING SYSTEM OPERATING COSTS														
Heating Oil Fuel Cost (Peak and Low Load)	$ 6,452	$ 6,827	$ 7,223	$ 7,642	$ 8,085	$ 8,554	$ 9,050	$ 9,575	$ 10,130	$ 10,718	$ 14,208	$ 18,834	$ 24,968	$ 33,098
Wood Fuel Cost	$ 20,809	$ 21,225	$ 21,649	$ 22,082	$ 22,524	$ 22,974	$ 23,434	$ 23,903	$ 24,381	$ 24,868	$ 27,457	$ 30,314	$ 33,469	$ 36,953
O&M Cost	$ 6,000	$ 6,120	$ 6,242	$ 6,367	$ 6,495	$ 6,624	$ 6,757	$ 6,892	$ 7,030	$ 7,171	$ 7,917	$ 8,741	$ 9,651	$ 10,655
Electrical Cost	$ 853	$ 879	$ 905	$ 932	$ 960	$ 989	$ 1,019	$ 1,049	$ 1,081	$ 1,113	$ 1,291	$ 1,496	$ 1,735	$ 2,011
TOTAL	**$ 34,114**	**$ 35,050**	**$ 36,020**	**$ 37,024**	**$ 38,064**	**$ 39,142**	**$ 40,260**	**$ 41,419**	**$ 42,622**	**$ 43,870**	**$ 50,872**	**$ 59,386**	**$ 69,822**	**$ 82,717**
PROJECT RELATED DEBT														
Beginning Principal Balance	$ 1,280,000	$ 1,221,868	$ 1,163,155	$ 1,103,855	$ 1,043,962	$ 983,470	$ 922,374	$ 860,666	$ 798,341	$ 735,392	$ 411,082	$ -		
Principal Repayments	$ (58,132)	$ (58,713)	$ (59,300)	$ (59,893)	$ (60,492)	$ (61,097)	$ (61,708)	$ (62,325)	$ (62,948)	$ (63,578)	$ (66,821)	$ -		
Interest Payments	$ (12,800)	$ (12,219)	$ (11,632)	$ (11,039)	$ (10,440)	$ (9,835)	$ (9,224)	$ (8,607)	$ (7,983)	$ (7,354)	$ (4,111)	$ -		
Ending Principal Balance	$ 1,221,868	$ 1,163,155	$ 1,103,855	$ 1,043,962	$ 983,470	$ 922,374	$ 860,666	$ 798,341	$ 735,392	$ 671,815	$ 344,262	$ -		
TOTAL DEBT PAYMENT	**$ 70,932**	**$ 70,932**	**$ 70,932**	**$ 70,932**	**$ 70,932**	**$ 70,932**	**$ 70,932**	**$ 70,932**	**$ 70,932**	**$ 70,932**	**$ 70,932**	**$ -**	**$ -**	**$ -**
ANNUAL OPERATING COST SAVINGS (LOSS)	**$ 429,372**	**$ (16,715)**	**$ (12,556)**	**$ (8,135)**	**$ (3,437)**	**$ 1,556**	**$ 6,859**	**$ 12,493**	**$ 18,476**	**$ 24,829**	**$ 62,963**	**$ 185,181**	**$ 253,979**	**$ 346,080**
Cash Investment (equity)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -				
Income (cost savings)	$ 429,372	$ (16,715)	$ (12,556)	$ (8,135)	$ (3,437)	$ 1,556	$ 6,859	$ 12,493	$ 18,476	$ 24,829	$ 62,963	$ 185,181	$ 253,979	$ 346,080
Net Cash Flow	**$ 429,372**	**$ (16,715)**	**$ (12,556)**	**$ (8,135)**	**$ (3,437)**	**$ 1,556**	**$ 6,859**	**$ 12,493**	**$ 18,476**	**$ 24,829**	**$ 62,963**	**$ 185,181**	**$ 253,979**	**$ 346,080**
ACCUMULATED CASH FLOW	$ 429,372	$ 412,657	$ 400,101	$ 391,965	$ 388,529	$ 390,084	$ 396,944	$ 409,437	$ 427,913	$ 452,742	$ 686,756	$ 1,504,046	$ 2,628,302	$ 4,163,802

IRR on Equity	10 YR IRR	15 YR IRR	20 YR IRR	25 YR IRR	30 YR IRR

Net Present Value (NPV)		10 YR NPV	15 YR NPV	20 YR NPV	25 YR NPV	30 YR NPV
NPV Discount Rate	3.0%	$ 428,805	$ 586,718	$ 1,065,378	$ 1,633,409	$ 2,302,680